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A superior solidboard box for bell peppers

Quantification of its benefits in a case study: the export of Dutch bell peppers to Detroit, USA, comparing the standard to the new box.

CONFIDENTIAL

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Executive Summary

Within the Modified Atmosphere project a so-called MH package was developed for bell peppers. The aim of the case study was to identify and quantify the advantages of the MH box over the standard bell pepper box with respect to the bell pepper quality in an existing distribution chain from the Netherlands to Detroit, USA. This test case should identify opportunities and risks for a market approach of the MH box in particular and MA packages in general.

The case study was a great success. A gain in storage time of ± 10 days (limit of the experiment) was achieved. Analysing the bell pepper quality data showed that an extension in the order of 14 days or more appears possible.

The enormous gain in storage time can be converted into benefit by:

a) using the extra storage time for cheaper transport, e.g. replacing air by sea transport.

b) selling the bell peppers as fast as possible with the highest quality (quality driven market).

c) opening new markets which cannot be reached with the currently allowed distribution time. Air and truck transport are combined.

d) using the extra storage time to increase the merchandising flexibility, balancing supply & demand.

A further advantage of the MH box is the reduction of the weightloss of bell peppers. This is a direct profit to the mechandizers who can reduce the surplus of product weight and simultaneously reduce airfreight costs. The weightloss after a lead time of 7 days (when both box types are still salable) is 1.8% and 3.4% , for the MH and standard bell pepper box respectively.

It is clear that the mechandizer is the first link in the distribution chain who will profit from the implementation of a MH box.

As a result of the case study, Botman International bv would like to order 1,500,000 boxes for the season of 1997 to export bell peppers to all kind of intercontinental markets. This is already a direct confirmation that there are opportunities for the commercial use of MA packages.

1) General introduction of the case study

1.1) objectives of the MAP project

The aim of the Modified Atmosphere transport packaging project is to develop intelligent transport packaging systems to deliver:

a) an improved product quality at the distribution outlet
b) a sustainable product quality throughout the distribution chain
c) an increased shelf-life of the product at the distribution outlet
d) reduction in the distribution costs
e) decreased losses of product within the distribution chain

Within the project three type of packaging systems were identified based on their functionality:

1) Modified Atmosphere (MA) packages
In the MA packages, the functionality is extended by a modification of the oxygen and carbondioxide concentration inside the package. The driving force for the modification is the respiration of the product, consuming O_2 and producing CO_2. The final O_2 and CO_2 concentrations reached are determined by the respiration activity of the product and the gas flux through the package (a combination of diffusion through the material and leakage through holes in the construction). MA packages require a gastight construction.

2) Modified Humidity (MH) packages
In MH packages, the humidity is modified in order to influence the evaporation of the product. The functionality of a MH package can be influenced by the:
   a) water vapour transmission rate of the packaging materials
   b) vent holes in the packages
   c) application of water absorbing and releasing materials
The MH package can be either open or gastight.

3) Intelligent packages
For intelligent packaging systems, the conditions inside the package are influenced by active compounds. The package responds to changes in its environment or to changes of its contents.

The increased functionality of the new packages leads to an increased added value of the package and its content. It will strongly improve the competitive position of the packages on the market and furthermore opens new markets for the products. Both options should result in the final objective: sell more packages.

1.2) benefits of MHP

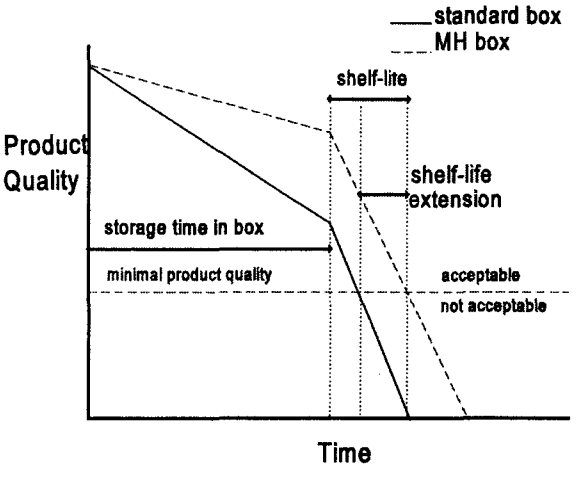
Modified Humidity (MH) packages are designed to retain the quality of a product for a longer time than the present packages. In principle, this advantage can be used in two ways, illustrated by the figures 1 & 2.

Firstly, given a distribution chain and a fixed lead time, the product quality at the retail outlet is significantly higher when a MH box is applied. This can be made profitable in a quality driven market.

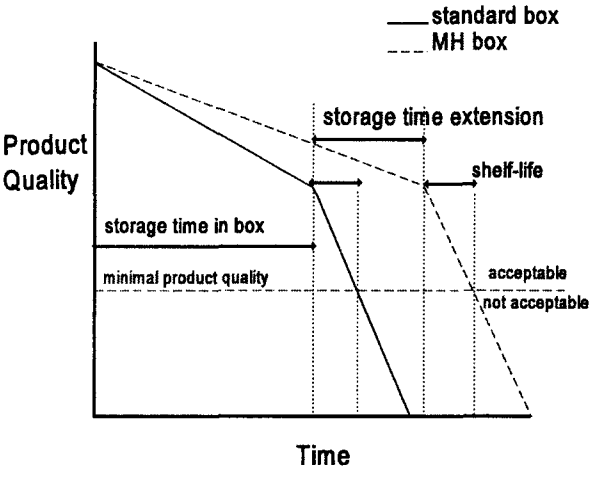
Secondly, given a fixed product quality at the retail outlet, the lead time for the distribution is extended considerably by the MH box. The extra storage time provided enables a slower but more cost effective transport. Alternatively, a more efficient balancing of supply and demand becomes feasible when the product is delivered from stock.

The two above discussed applications clearly show that the benefits of a MH package is either a gain in quality or a gain in time. Note that quality is exchangeable with time. Therefore, the quality enhancement created by the use MH box is expressed in days of extra shelf-life (storage at living room conditions).

The gain in either distribution lead time or product quality achieved by the MH box can be made profitable in different ways:



Afbeelding 1 The MH box extends the *shelf-life* of bell peppers when the distribution lead time is fixed.



Afbeelding 2 The MH box extends the *storage time* of bell peppers when the quality at the retail outlet is fixed.

a) using the extra storage time for cheaper transport e.g. from air to sea transport.
b) selling the bell peppers as fast as possible with the highest quality (quality driven market).
c) opening new markets which cannot be reached with the currently allowed distribution time. Air and truck transport are combined.
d) using the extra storage time to increase the merchandising flexibility, balancing supply & demand more effectively.

1.3) motivation of the case study

In the first year of the project, the main focus was the development of a gastight construction made of solidboard. At the same time, the market perspectives of a MA/MH box were investigated. It appeared that it was difficult to quantify the benefits and subsequently identify the market opportunities. Furthermore, the added value of a MA/MH box was proven in laboratory conditions but not in a real commercial distribution chain.

Therefore, it was decided to perform a case study in order to prove that the MA/MH concept works on commercial basis and to elucidate on the added value of MA/MH in order to identify the market opportunities of the MA/MH concept. In order to reduce the risks caused by the not fully developed packaging designs, it was decided to test a MH box with Dutch bell peppers transported from the Netherlands to the United States.

The original objectives of the case study were to answer the following questions:

a) Are bell peppers salable after 0, 3 and 7 days extra storage time ?
b) What is the bell pepper quality difference between the standard and the new MH box at these times ?
c) What is the extension in extra storage time ?
d) Can the results of the case study be reproduced at the laboratory ?

To answering the last question, an experiment mimicking the distribution chain conditions was performed at the laboratory of ATO-DLO.

In addition, inventories were made of opinions and recommendations for improvements of packages by interviewing persons in the distribution chain. Emphasized were opinions and recommendations concerning the tested bell pepper boxes but boxes for perishables in general were also addressed.

2) Summary of the case study results

2.1) objective

The objective of this case study was to identify and quantify the advantages of the MH box over the standard box with respect to bell pepper quality in an existing distribution chain from the Netherlands to the USA.

Prior to the case study, it was decided that the criterium by which the performance of the box is judged is a gain in storage time. In section §1.2 it is explained that a gain in product quality is directly related to a gain in storage time.

2.2) method

Per shipment 2 pallets of standard bell pepper boxes and 2 pallets with the new MH box were transported by air from the Netherlands to Detroit, USA. A total of ±700 boxes were used. At the wholesaler in Detroit an extra storage time of 0, 3, 7, or 10 days was incorporated. The quality of the bell peppers was determined for all box-type and storage time combinations. When the quality was acceptable, the bell peppers were send to the retail awaiting to be sold. The transport to the USA was performed twice, with an interval of three days, in order to reduce the risks. At the same time, a laboratory test at ATO-DLO was performed in order to confirm the relation between the real distribution and the simulation experiments at ATO-DLO.

2.3) quantification of the extra storage time.

A box-storage time combination is judged to be acceptable when the bell peppers have a quality that allows approximately 2 days shelf -life at the retail.
The maximum extension in storage time achieved by the MH box in comparison with the standard box was 7 days, based on the bell pepper sales at the retail. Based on the bell pepper quality, the maximum extension of the storage time was 10 days. Both extensions correspond to the detection limit of this case study. Thus, the maximum extra storage time found in this study is not the absolute maximum storage time that can be reached. Data analyses revealed that the extension may well be in the order of 14 days or more. This seems very promising for replacing the costly air transport by cheap sea transport.

2.4) comparison of the bell pepper quality.

The quality of the bell peppers in the MH box is significantly better than those in the standard box at every observed lead time. The quality of the bell peppers in the MH box at the maximum applied lead time of 14 days was still higher than that of those in the standard box at a minimal lead time of 4 days. Moreover, the quality difference at any time was so obvious that non-product experts could see it.

Even without an extra storage time, the bell pepper quality was improved considerably by applying the MH box. As a consequence, given the current distribution chain implementation of the MH box already leads to a significant improvement of the bell peppers quality at the retail.

2.5) comparison of the different shipments

Both shipments of bell peppers to the USA and the simulation test at the laboratory of ATO-DLO all led to the same conclusions, which strengthens their validity. Still, some additional remarks should be noted. The conclusions apply to a relatively homogeneous bell peppers quality at the moment of harvest, because one grower supplied both batches of bell peppers within a relatively short time of 3 days. How this initial bell pepper quality relates to the quality at other times in the season or to other origins was not evaluated. The experiment was performed at the end of the harvesting season. Prior to the case study, the harvested volume of the bell peppers dropped weekly from 1 to 0.5 to only 0.2 kg/m^2 , which might indicate a concomitant decrease in product quality. On the other hand, Botman International bv carefully selected the grower involved, which might indicate an above average product quality.

2.6) value of the laboratory experiment at ATO

The simultaneous experiment at ATO-DLO with slightly different temperature settings led to the same conclusions as found for the case study. Thus, it can be concluded that the experiments at ATO-DLO can be used for further optimization of the MA and MH box. Large tests focussed on the product quality such as the one discussed in this report can be reduced to a minimum.

3) The case study from a product quality perspective

This chapter will focus on the most important aspect of the case study: the quantification of the performance of the new Modified Humidity (MH) box in retaining the bell pepper quality during the export from the Netherlands to Detroit, USA. The MH box will be compared to the standard box. The objectives set, the methods used and the results achieved will be elaborated on.

3.1) objectives

The MH box was developed to be more efficient in retaining the bell pepper quality than the standard box. Applying this MH box in a distribution chain should therefore result in a higher product quality at the retail outlet or in an extended storage time when no higher product quality is required, as is explained in §1.2. For this case study, the influence of the box type on the storage time extension was emphasized. Included was also the effect of the position of a box in a pallet stacking.
The changes in product quality in time were quantified by addressing the following questions:

a) Are bell peppers salable after a distribution lead time of 4*, 7, 11 and 14 days ?
b) How much product weight is lost at these times ?
c) What is the bell pepper quality at these times ?
d) Can the results of the case study be reproduced at the laboratory ?

*: the minimal lead time of the distribution chain is 4 days.

The benefit of the MH box in retaining the product quality more efficiently was determined by comparing the product quality of bell peppers in the standard box versus that of the MH box.

3.2) methods

The bell pepper quality determination is a sensoric assessment of the aspects firmness, shrivelling and rot (see appendix 1: product quality). These aspects cover the most abundant quality problems that can occur with bell peppers: softening of the tissue, shrivelling of the skin and rot spots on the skin. The sensoric determination results in the assignment of a class value from 0 up to 5, with 0 as an excellent and 5 as a poor quality.
The quality of bell pepper was determined at the wholesaler in Detroit after 4, 7, 11 and 14 days distribution lead time. At these times, the cold storage was ended and bell peppers were exposed to 'living room' conditions for maximal 6 days. The product quality was determined daily in order to determine the shelf-life: the time the product quality exceeds a certain minimum quality level. Lead times for the distribution of bell peppers were acceptable when the shelf-lives exceeded 2 days. The quality of bell peppers in a box was determined 576 times. The quality of individual bell peppers was determined more than 14,000 times.

extra storage time	minimum lead time	
	until wholesaler, Detroit	until retail, Detroit
0	4	5
3	7	8
7	11	12
10	14	15

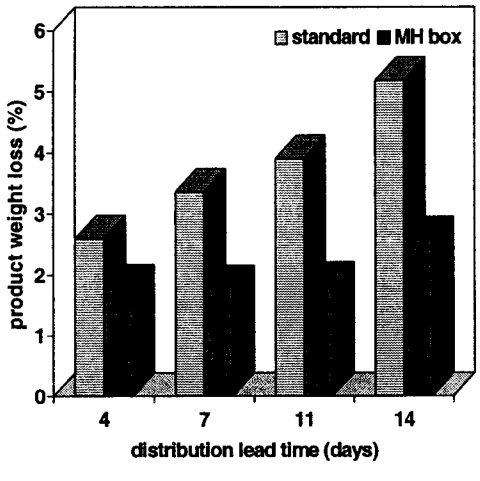
Time schedule of the case study. The minimum distribution lead times, combined for two shipments, are shown.

3.3) results

In this section a brief overview will be given of the results related to the product quality. These results are also provided in more detail in the appendix 2.

3.3.1) product weight

Bell peppers lose weight during the transport and storage due to the evaporation of water. This weight loss is anticipated for: a net weight of 5kg at the retail is guaranteed by filling at least 5.1kg product per box at the grower. This surplus of product allows a weight loss of about 2%. Weight losses represent an important cost factor especially in view of the large volumes of bell peppers exported.

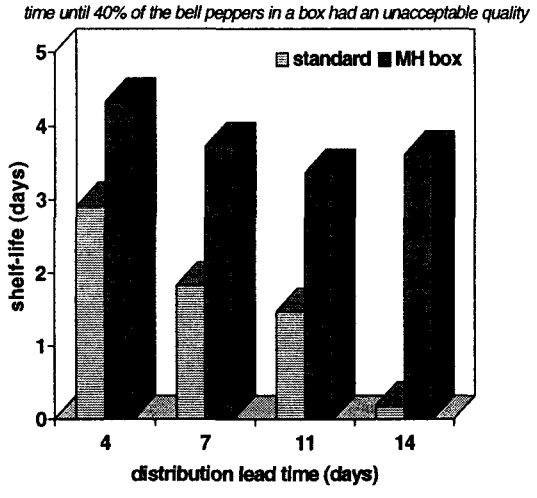


Afbeelding 3 The *weight loss* of red bell peppers after the indicated distribution lead times and per box type.

Bell peppers in the MH box lost considerable less weight than those in the standard box, see figure 3. The benefits of the MH box in this respect are twofold. Firstly, less surplus product needs to be filled at the grower or more product can be sold at the retail. Secondly, transportation costs can be reduced. Again, in view of the large volumes bell peppers exported this benefit is quite substantial.

This result clearly shows that the MH box is superior in preventing weight losses of product due to dehydration.

3.3.2) product quality



Afbeelding 4 The *shelf-life* of red bell peppers after the indicated distribution lead times and per box type.

The shelf-life of the product is used as a measure of product quality and is expressed as the number of days that the product quality exceeds a minimum acceptable level. The USA standard for a minimal bell pepper quality, which is used by traders, was used as the criterium: 40% of the bell peppers per box have a quality class above 3 (see appendix 1; product quality).

It was quite obvious that the quality of bell peppers in the MH box was superior to that of the bell peppers in the standard box (see figure 4). The quality of bell peppers in the MH box exceeded that of those in the standard box at all lead times.

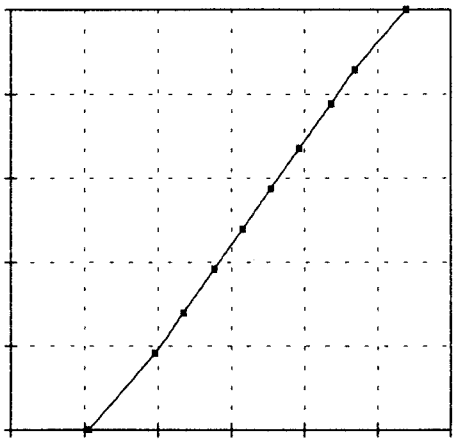
In particular, the quality of the bell peppers in the MH box at the maximum lead time of 14 days was higher than that of the standard box at the minimum lead time of 4 days. An extrapolation of the shelf-life results indicate that a lead time up to approximately 18 days seems acceptable for the MH box.

This result clearly shows that the storage time of bell peppers can be extended for at least 10 days by applying the MH box in stead of the standard box.

Both in the case study and in the laboratory experiment, the quality problem rot was hardly observed. The occasional observation of rot spots on a bell peppers were too small in number to enable or justify an analysis. As a consequence, conclusions on the effect of the box type on the susceptibility for rot could not be made. However, the exceptional occurrense of rot seemed not related to the box type. Still, this aspect should be kept in mind because condensation of water vapour on the bell peppers was observed frequently and especially for bell peppers in the MH box.

The quality of the bell peppers was also assessed by an alternative method: supply them to and record the sales at the retail. Bell peppers in the standard box were sold here for a lead time up to 7 days. The maximum acceptable lead time tested for bell peppers in the MH box was 14 days. Quality problems were not reported, the customers were satisfied with the provided quality. Thus, an lead time extension of 7 days was demonstrated for the MH box, but further extensions seem quite feasible.

3.3.3) relation between weight loss and product quality



Afbeelding 5 Relation between *product weight loss* and *product quality* of red bell peppers.

The decline in product weight and product quality occurred with the same rate. Thus, a close relation between these two parameters seemed feasible. Indeed, the results obtained in the laboratory experiment showed a linear relation between weight losses and quality deterioration for bell peppers, as is shown in figure 5.

Most of the differences in product quality (97%) could be accounted for by the weight losses observed. This result implies that the quality of bell peppers can easily and accurately be determined by weighing, provided that the initial weight is known.

This result clearly shows that bell pepper quality deterioration is mainly caused by the evaporation of water and can easily be determined by measuring weight losses.

3.3.4) position of box in pallet

The weight losses and quality of bell peppers was determined for boxes in different positions within the pallet. Distincted were the top, middle and bottom row of a pallet. Furthermore, within a row a distinction was made between boxes exposed to the surrounding environment (outside) and boxes fully enclosed by other boxes (inner side). Effects of the box position on the weight loss and quality of the product were not observed, although slightly higher temperatures were observed inside the pallet during the distribution.

This result clearly shows that the outstanding performance of the MH box can solely be attributed to its design.

3.3.5) comparison of case study and laboratory experiment

At the ATO-DLO an experiment was performed that mimicked the case study. The same batch of bell peppers, equal lead times and similar conditions were applied. The results of this experiment strongly resembled that of the case study, with respect to product weight losses, product quality and maximal lead times. Detailed information is provided in the appendix 2.

The resemblance in results implies that experiments with bell peppers under 'laboratory' conditions are valid for a 'real-life' test situation.

The practical implications of this result are great: laboratory experiments are easier and cheaper. In addition, the confidentiality is guaranteed. A case study involves the co-operation and commitment of a large number of people and less sophisticated the facilities 'in the field'. On the other hand, the case study and the laboratory experiment are not fully equivalent. Additional information is obtained by a case study, e.g. information needed for an optimal implementation of a new packaging concept. Furthermore, promotion activities are possible.

3.6) conclusions

Conclusions drawn for the case study with respect to the bell pepper quality are:

1) the case study was very successful, all objectives were achieved and clear conclusions could be drawn.
2) Bell peppers are salable after a distribution lead time of 4, 7, 11 and 14 days when the MH box is applied. For the standard box, lead times of only 4 and 7 days were acceptable.
3) An extra storage time of 10 days was achieved by the MH box, based on the product quality results. Based on an extrapolation of these results, an extra storage time of 14 days seems feasible.
4) The bell pepper quality of the MH box always exceeded that of those in the standard box. Moreover, bell peppers in the MH box at a lead time of 14 days still had a higher quality than those in a standard box at 4 days lead time.
5) Product weight losses for bell peppers in the standard box by far exceeded that of those in the MH box, respectively 3.4 and 1.8% at 7 days lead time.
6) Weight losses are a good measure of bell pepper quality deterioration.
7) The position of the box in the pallet did not effect the quality of the bell peppers for both the standard as the MH box.
8) The box type effects on the product quality were similar for the case study and the laboratory experiment performed at the ATO-DLO.

4) The case study from a package perspective

4.1) objective

The objective of the case study is to determine the advantages and the disadvantages of the selected MH box in an existing distribution chain. The added value of the box is judged by the quality of the bell peppers. The standard solid board bell pepper box (1996; referred to as the 'standard box'), which is currently commercially used, is used as a reference in this case study. The properties and behaviour of the MH box are discussed in this chapter.

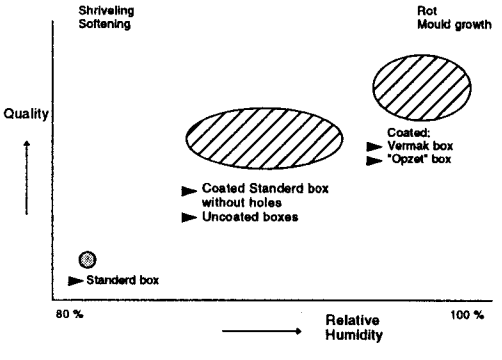
4.2) box functionality

The extended functionality of the new MH box is obtained by an increased humidity of the enclosed volume surrounding the product, in comparison to the standard box. The humidity is expected to be between 95 and 100%. The humidity in the box is influenced by:

a) the transpiration rate of the bell peppers.
b) the number, location and surface of ventholes.
c) the use of water vapour barriers on the board.

4.3) selection of the box

Prior to the case study a wide scan of box designs was performed, which included variations in ventholes and the application of PE (PolyEthylene) sandwich liner as water vapour barrier. A schematic overview of the results is shown in figure 6. This figure illustrated that three classes of package could be identified.



Afbeelding 6 Schematic overview of the performance of different packaging designs in relation to the bell pepper quality.

1) the first class of packages, performing the poorest, contained the standard bell pepper box. The humidity inside the boxes is in the order of 85%.
2) All packages in the second class perform significantly better than the first class. The class contains a wide variety of packages: with and without sandwich PE liner and a variety of vent holes. The average humidity is these boxes is approximately 92%.
3) The last class of packaging designs are those packages that reach a saturated humidity under a wide range of distribution conditions. Theoretically, this packages will perform optimal in reducing the water evaporation of the enclosed bell peppers, but this is achieved at the expense of an increased risk for rot and mould occasionally found for a non-optimal initial produce quality.

The box design finally selected for the case study meets the following criteria:

a) The box must maintain its compression performance. Therefore, it was decided that the box must have a PE sandwich liner.
b) Given the higher risk of mould and rot for the box designs in class three, it was decided to select a design with properties of class 2.

The design of the final MH box includes:

a) the dimensions of the standard bell pepper box.
b) instead of the usual vent holes, including the handles, only two holes are applied. Each hole with a diameter of 1.5 cm is positioned on the long vertical side wall.
c) a PE sandwich liner is applied.

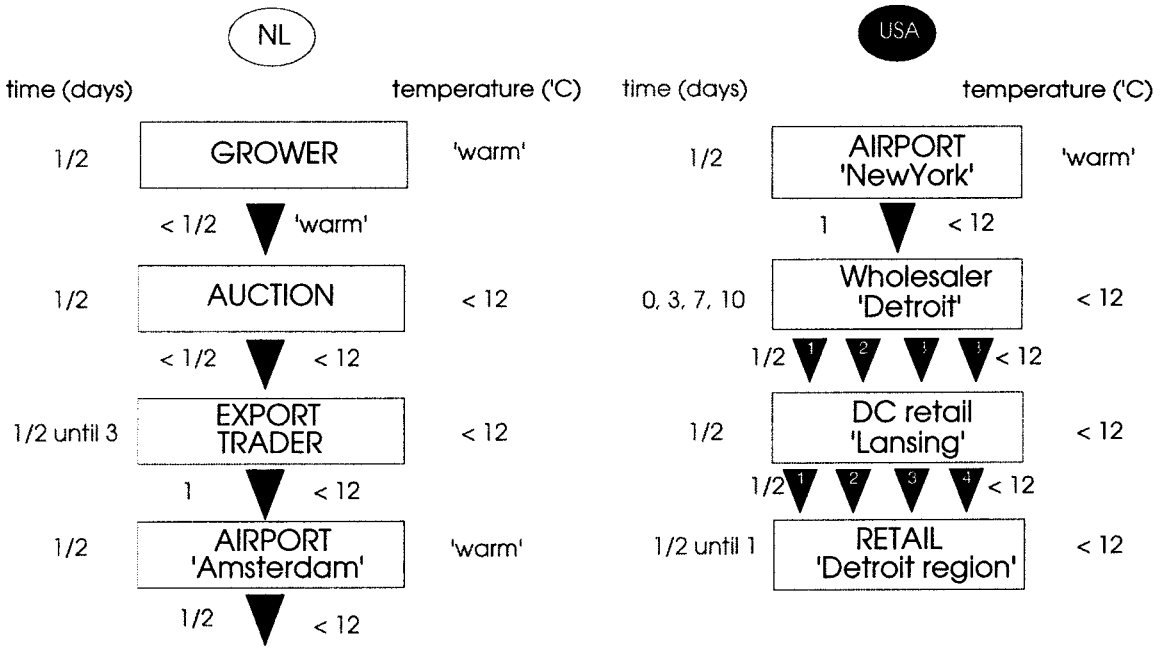
This particular box was not included in the box design scan procedure.

The box performance in the case study can be summarized by:

a) the MH box performs significantly better that the standard box (see chapter 3).
b) in the case study no severe box compression problems were encountered.
c) condensation of free water was observed in the MH boxes.
d) the humidity was saturated in the MH box.
e) the bending of the ground plate and lid was less severe for the MH box than for the standard box.

5) The case study from a distribution chain perspective

The case study could only be realized by the co-operation and commitment of a large number of people both in the Netherlands and in the USA, mentioned in the acknowledgement.



Afbeelding 7 The distribution chain of the case study for bell peppers. Locations, lead times and estimated temperatures are shown. At the wholesaler in Detroit, the shipment of bell peppers is divided into parts that are stored here for different times. The resulting minimum lead times from grower until the retail were 5, 8, 12 and 15 days.

5.1) the distribution chain

Figure 7 shows the distribution chain used for the export of Dutch red bell peppers to the retail in Detroit, USA. Indications of lead times and expected temperatures are given.
Bell peppers are harvested, sorted on size and packed in boxes at the grower. The boxes are placed in pallets, 8 rows of 10 boxes each. Subsequently, the pallets are transported by truck to the auction to be precooled here. The quality is inspected the next morning for the customs clearing. The export trader arranges shipment freights that are placed on airplane pallets (5 to 6 pallets each) at the expeditor, located near the auction. Pallets are fastened by nets. Next, the shipment is transported by truck to the airport. After a variable extra storage time, the airplane pallets are placed in the airplane. The flight to the USA takes about 8 hours.
At the USA airport, the airplane is unloaded and inspected for the customs clearing by the custom broker. Then the shipment is transported by truck to wholesaler in Detroit, and stored here cold. After a variable time, the bell peppers were either used for product research at the wholesaler or transported by truck to the distribution centre of the retail at Lansing. Finally, the bell peppers are transported to the retails in the region of Detroit. The minimum lead time for the whole transport from grower to retail is approximately 5 days.

5.2) actors in the distribution chain

grower
The red bell pepper 'Mazurka' was harvested by hand in the early morning. For 'super ' export quality used in the case study the size of 80 to 100mm diameter was sorted out. Individual bell peppers were stickerd with a code for identification in the retail. These bell peppers were packed in 20*30*40cm boxes of net 5 kg (11 lbs). A product surplus of 100 grams was added. For the case study 4 pallets of 80 boxes (8 rows per pallet) were used. This shipment was repeated after 3 days.

auction/export trader
At the auction, the bell peppers were pre-cooled and inspected for the customs clearing. The expeditor, located at the auction facilities, arranged the placing of pallets on larger airplane pallets that enable to fix the position of the shipment in the airplane. The export trader arranges the airplane company and destination of the shipment.

airports
The airport used for the case study was Schiphol, close to Amsterdam. However, other airports in Europe may also be used. The choice depends on the airfreight space available and the price of transport. The destination airport is also variable. For the region Detroit, both New York and Chicago were used.

custom broker USA
The custom broker takes care of all custom formalities at the USA border, including a large amount of documents and a fytosanitairy inspection of maximal 10% of the freight. A high efficiency is persued by reducing the time required and the number of rejected freights.

wholesaler Detroit
Perishables are stored here temporary, awaiting a further distribution. The function of this link is twofold: produce can be delivered faster from stock upon a request and in case of quality problems an alternative client can be found.

DC retail/retail
The retail provided the consumer with products. For produce, a minimal lead time and a maximal quality is persued. The throughput is high. The quality of Dutch produce is regarded as the best.

5.3) opinions on the box functionality

The actors in the USA were confronted with the quality of the bell peppers in the standard box and in the MH box. Without exception, the higher quality of the bell peppers in the MH box was judged to be very obvious. Especially the extreme firmness of the bell peppers, not frequently observed, was noted.

The actors in the distribution chain were also interviewed on the functionality of packages in general. Packages of Dutch origin were judged to be among the highest quality packages available, much better than packages of domestic produce. Still, some possibilities for improvement were mentioned:

a) The dimensions of the bell pepper box are not optimal in displaying the product at the retail. A larger display area will stimulate the sales. Boxes with two layers of product are preferred. Note: printings are not visible during the display.
b) The strength and tolerance for humidity can be improved. Especially flower boxes are known for mechanical problems. In this respect, the MH box is already an improvement of the standard bell pepper box.
c) High lids of boxes that can contain the product of a box are preferred. At the custom clearing, the lids are used to temporarily hold the inspected product. Low lids cause losses of salable product due to hygiene problems.
d) Handles, not available for the MH box, are preferred. This aspect was mentioned primarily because the omission of handles was noted as a deviant aspect. However, problems with handling the MH box were not mentioned.

5.4) impact of a higher product quality

The USA market is quality driven. This means that an improved product quality is expressed in a higher price at the retail. The observed price differences were substantial:

a) Average quality bell peppers of domestic produce were sold at $1.00/lbs
b) High quality Dutch bell peppers, in a standard box, were sold at $3.00/lbs

A still higher quality Dutch bell peppers at the retail, achieved by the MH box, can probably be sold at an even higher price.

Besides effects of product quality on the price, product quality can also influence the fraction of perishables not sold. Produce is removed from the display when the quality becomes unacceptable. A higher initial quality product will result in a reduction of the fraction unsold product. An indication of the volumes involved at the retail is:

a) On average, 5-6% of the perishables is lost
b) Frequently, 10-15% of lower quality perishables are lost
c) Less than 5% of the Dutch perishables, of above average quality, are lost.

6) Spin-offs and future activities

6.1) spin-offs

The case study was performed and the requested information was obtained. A significant improvement in retaining the bell peppers quality was achieved by the MH box in comparison to the standard box, at all times and locations in the USA. The retention of quality can be expressed as an increase in storage time of 7 or 10 days, based on a comparison with the standard box and based on distribution lead times respectively. Both storage time extension values were detection limits. Extrapolation of bell pepper quality data suggest an extension of the storage time in the order of 14 days or more.

Given the good performance of the MH box, Botman International bv would like to order 1.500.000 MH box for the season of 1997. The export of bell peppers would not only involve Dutch bell peppers to the USA, but various intercontinental distribution chains such as the Netherlands-Japan, Spain-USA, New Zealand-Japan etc..

Furthermore, the contacts with case study participants in the USA have led to the identification of other Dutch products with good marketing perspectives for MH and MA packages. The suggested products included both bulk products and nice market products. The mentioned products were: tomato, tomato on a vine, strawberry, Belgium Endive, Radicchio Rosso.

6.2) future activities

The case study resulted in the formulation of the following questions:

a) *Is sea container transport possible when the storage time is extended for more than 10 days as a result of applying the MH box?*
This question can be answered by performing an experiment where the bell peppers are stored for at least 14 days at a low temperature, simulating the conditions in the container.

b) *What is the effect of the initial quality of the bell pepper?*
As has been discussed in the report, the variation in initial quality of the bell peppers used is deliberately chosen to be rather small in order to obtain reproducible results. The initial quality of the bell peppers and their sensitivity to mould, rot and weight losses vary between cultivars, over the season and from one season to another. The variation is further extended when also non-glasshouse produced bell peppers are used. This is relevant for bell peppers originating from Spain and New Zealand.

c) *What is the effect of the temperature fluctuations?.*
The case study showed that the effect of small variations in temperature on product quality were rather small. Nevertheless, the effect of initial higher temperatures than tested here, e.g. ± 25°C, should be verified to anticipate on conditions frequently occurring during a Dutch summer. An experiment with an initial high temperature of the bell peppers is recommended.

d) *Which MH box design will be introduced to the market?*
The evaluated MH box was a prototype which can be further optimized with respect to production costs, box compression strength and product quality performance. Possible alternatives for the tested MH box should be evaluated in the near future.

e) *Introduction to the market.*
Now Botman International bv has asked for 1.500.000 MH boxes for 1997, a detailed marketing plan has to be developed.
Important aspects are:

- *Image of the MH box*
  The image of a box must be carefully build. It is not just a box, it should be more like a brand. Trading a box, is selling a box *and* delivering a high quality product to the costumer. The MH added value can be incorporated in the chain evaluation program, developed by J.W. van der Veen, which subsequently can support the marketeers of KNP BT.
  The MH box will be applied in the high quality segment. It may be useful to claim the knowledge intensity of the box, and refer to the co-operation with ATO-DLO. This is something the competitors don't have.
- *Protection of the knowledge.*
  It is clear that a protection mechanism has to be developed against competitors. Although in the project a lot of effort has been put in the direction to clarify the differences between MH, MA, gas packaging, and CA, it is preferred to use a rather vague term for all the packages, such as intelligent packaging. The latter would also correspond to the high added value image. Nevertheless, a simple picture to explain the principles of the package which can be used by the marketeers must be developed.
- *Pricing the MH box.*
  It is obvious that this aspect needs attention given the cost of the research and development and production of the box. The pricing should also be related to the expected price of the MA box and anticipated higher product prices.

Acknowledgements

The case study was a great success due to the full co-operation and commitment of the following persons within the distribution chain:

Grower	Aart van Zuidgeest
Exporter	Adri Botman, Ton Zwetsloot, Corine van Groeningen
Expeditor	Nico Zuiderwijk
Custom broker	Tony Fondacaro
Wholesaler	Steve Kernya
Retail	Roger Pepperl

Moreover, François de Rooij of the Hogere Agrarische School at Den Bosch, the Netherlands should be mentioned for his role as a guide during the stay in the USA.

We thank all participants of the case study and corresponding laboratory experiment for their efforts in making this study a great success. Furthermore, besides the good results the optimal co-operation made it possible to work in a very good atmosphere.

Appendix 1: Material and Methods

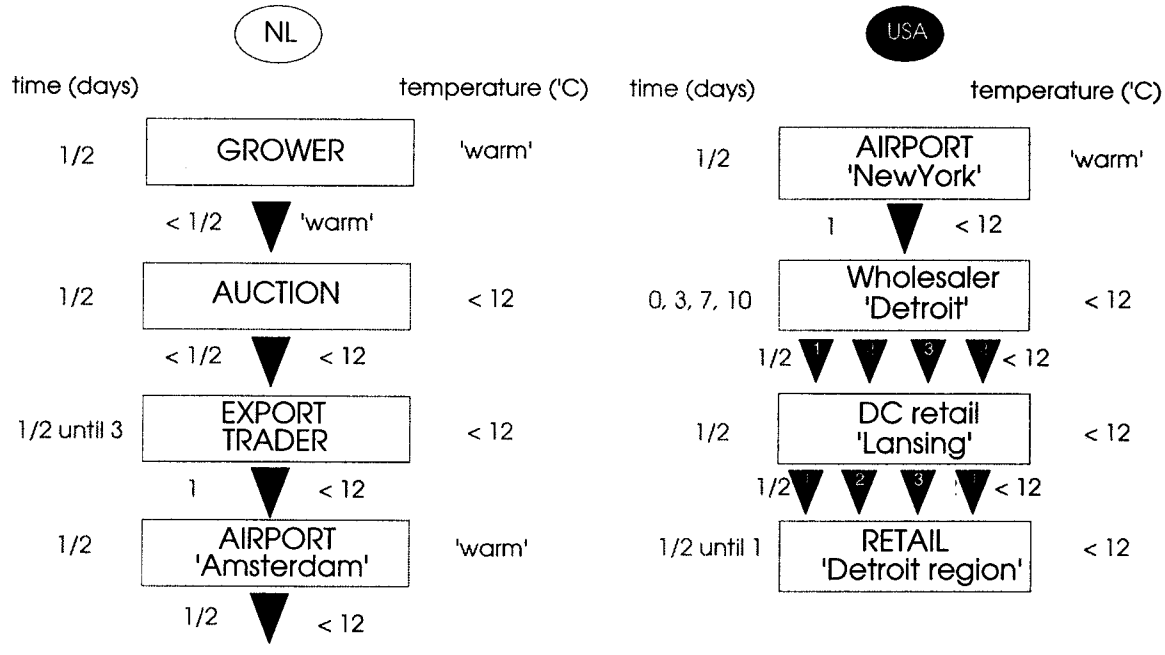


Figure 1 The distribution chain of the case study for bell peppers. Locations, lead times and estimated temperatures are shown. At the wholesaler in Detroit, the shipment of bell peppers is divided into parts that are stored here for different times. The resulting minimum lead times from grower until the retail were 5, 8, 12 and 15 days.

distribution chain

The distribution chain used for the case study for bell peppers was selected by Botman Int. bv and is shown in the figure 1 above. For each link in the chain the expected temperature of the product and the lead time are shown.

The grower was located at Poeldijk. Bell peppers were grown here and harvested, sorted and packed on 30 september 1996. Next, the bell peppers were transported by a truck to the auction for perishables at the Westland. The bell peppers were cold stored at the auction facility (export trader) pending the fytosanitairy inspection and customs clearing. Bell peppers ready for export were placed on an airplane pallet and transported by truck to the airport. The flight from Amsterdam (Schiphol airport) to New York (John F. Kennedy airport) took ±8 hours. Here, the bell peppers were inspected again and cleared for the customs by the custom broker. Subsequently, bell peppers were transported by a truck to Detroit, Michigan (±14 hours).

At the wholesaler RAM Produce Inc., the bell peppers were cold stored for different time intervals: referred to as extra storage times of 0, 3, 7 & 10 days. Next, the bell peppers were either used for

1) product quality research, determining the shelf-life of the product, or
2) used for the retail outlet, monitoring if the bell peppers were sold at the retail.

In case of the latter, the bell peppers were transported by a truck to a perishables distribution center at Lansing (± 2 hours) and from here distributed to retails in the state Michigan. Bell peppers were sold at the first (±70%) or second day (±30%) after arrival at the retail.

The shipment of bell peppers was repeated after 3 days. Bell peppers of the second shipment were harvested on 3/10/'96. The distribution chain and time planning of both shipments were similar, except for the destination airport. The flight of the second shipment had the destination Chicago. The truck needed 6 hours to get to Detroit. Choosing the airplane company and route is a 'last minute' activity of the export trader and depends on the availability of airfreight space at a specific moment.

day	date	place	action	day	date	place	action
0	30/09/'96	grower	harvest, sorting, packing, pallet stacking, transport	4 *+x* *+y* *+z*	04/10/'96	wholesaler, Detroit	cold storage, transport
1	01/10/'96	auction	storage, custom clearing, airplane pallet, transport	5 *+x* *+y* *+z*	05/10/'96	DC perishables, Lansing	cold storage, distribute load, transport
2	02/10/'96	airport (A'dam)	loading airplane, flight	7 *+x* *+y* *+z*	07/10/'96	retail Meijer, Detroit	display product, sale
3	03/10/'96	airport (NY)	unloading, custom clearing, transport	*extra storage time in distribution:* *x: 3 days*		*y: 7 days*	*z: 10 days*

Time schedule of the case study. Bell peppers were transported by truck and airplane from the Netherlands to the USA. At the wholesaler, the shipment was divided in three parts. One third of the shipment remained one day at the wholesaler, the distribution was not delayed. Two third of the shipment was cold stored for an extra 3 , 7 or 10 days, thus delaying the outlet. The first shipment was delayed for 0, 3 and 10 days, the second 0 and 7 days.

extra storage time	minimum lead times	
	until wholesaler, Detroit	until retail, Detroit
0	4	5
3	7	8
7	11	12
10	14	15

Time schedule of the case study. The minimum distribution lead times, combined for two shipments, are shown.

temperature, humidity and vibration

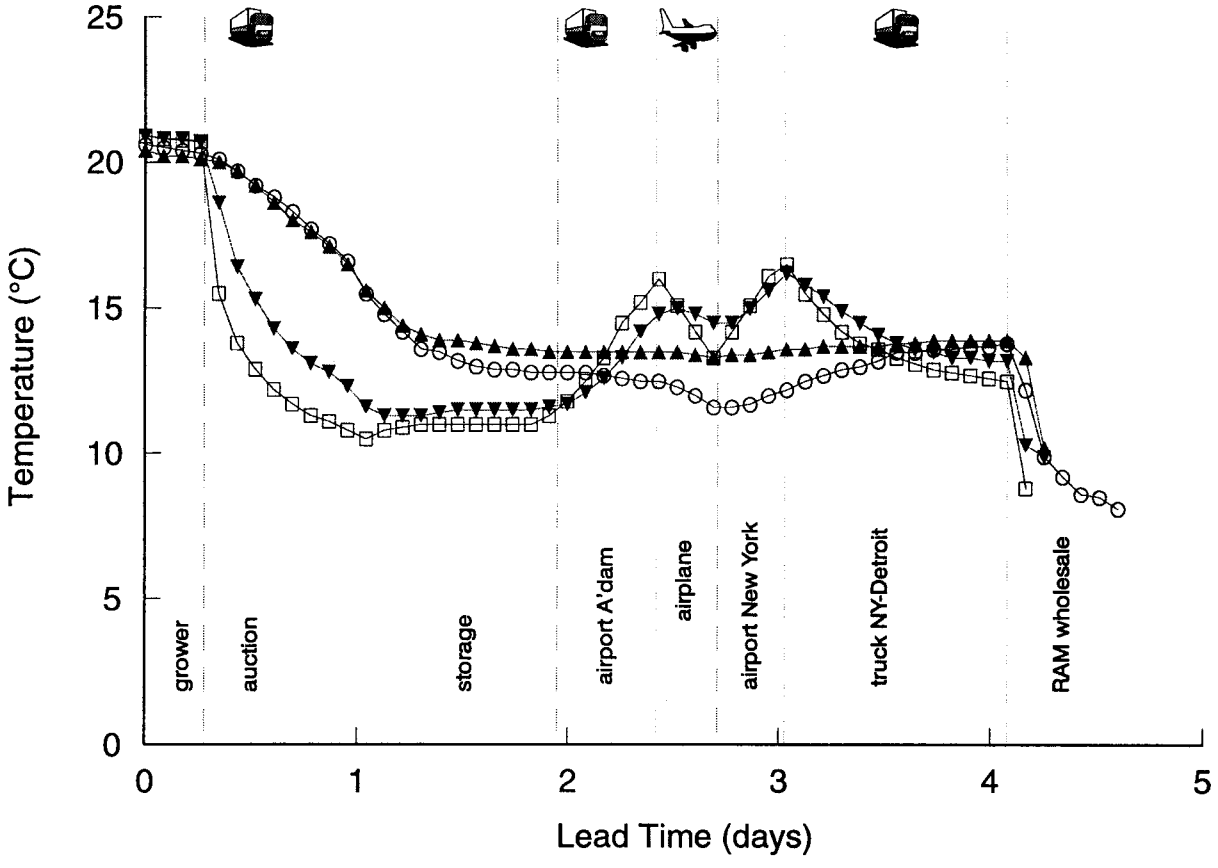


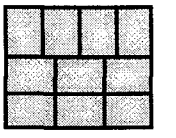
Figure 2 Temperature profiles of the distribution chain. The temperatures were recorded for the *standard box* (inner side:○, outer side:❑) and for the *MH box* (inner side:▲, outer side:▼).

Escort and Saver data loggers were included with the shipment to registrate fluctuations in temperature, humidity and vibrations. The first shipment contained 4 Escort (temperature and humidity) and 1 Saver (vibrations and temperature) data logger. The second shipment contained 3 Escort and 1 Saver data logger. The data loggers were placed in boxes at the grower. The boxes with Escort data loggers also contained bell peppers. The boxes with the Saver data logger contained no product. All data loggers were removed at the wholesaler in Detroit. The conditions at the retail outlet were not recorded because the risk of losing the expensive data loggers was estimated to be too high. The temperature profiles per boxtype and position within a box are shoen in figure 2.

product and package

Red bell peppers 'Mazurka' were harvested, stickered individually and subsequently sorted on size at the grower (Zuidgeest, Poeldijk). For the experiment a 'Super' quality bell peppers was used, of diameter 80 up to 100 mm. These peppers were packed in boxes of 5 kg net (11 lbs). Each box contained more than 5.1 kg product. The minimal surplus of 0.1 kg is needed for compensation of weight losses due to evaporation.

The dimensions of the both standard and MH boxes were 20 * 30 * 40 cm. Both boxes were manufactured and provided by KNP BT. The standard box was uncoated. The MH box had a PE coating on the kraft liner facing the interior of the box. Furthermore, the number of holes in the MH box was 2 (Ø 15 mm) in stead of 6 (Ø 25 mm) for the standard box. Finally, the MH box was clearly distinguished by the absence of handles and a yellow 'Culinair' printing, a Botman International BV brand.



pallet stacking

Boxes were individually numbered and stacked into pallets of 1.00 * 1.20 * 1.60 m. Every row contained 10 boxes. The pallet was eight rows heigh. Thus, each pallet holds 80 boxes. A total of 4 pallets were used for a single shipment. Two pallets with standard boxes with bell peppers and another two pallets with MH boxes. These pallets are placed on airplane pallet, a metal pallet of 2.44 * 3.18 * 1.94 m (code P6).
The laboratory experiment at the ATO-DLO was performed with 36 standard and 36 MH boxes with bell peppers.

product quality

The quality of the bell peppers was determined by a sensoric inspection. The quality aspects firmness, shrivelling and rot were determined for individual bell peppers and for all bell peppers in a box.

Firmness	is judged on a discontinue scale of **0 until 5** (good .. bad). *Zero means fully firm, five means fully softened bell peppers.* The range 0 to 5 is related to the amount of weight lost due to water evaporation. Zero stands for no loss, 3 for 4-5% loss and 5 for 10%(or more) loss of weight.
Shrivelling	is judged on a discontinue scale of **0 until 5** (good .. bad). Zero means fully firm, comparable to just harvested bell peppers with a fully smooth skin (0% shrivelled). Five means fully shrivelled bell peppers with skins that show no smooth area (100% shrivelled).
Rot	is judged on a discontinue scale of **0 until 5** (good .. bad). Zero means fully sound bell peppers, comparable to just harvested ones. Class 1 bell peppers show just visible rot spots (Ø mm). Class 5 bell peppers show rot spots all over.
Total	is judged on a binomial scale of **- or +** (not acceptable, acceptable). peppers are either acceptable or not acceptable for sale. As such, this criterium is a mix of the previous quality aspects. Bell peppers to be sold should acquire good marks for firmness, shrivelling and rot. In practice, firmness and shrivelling should be below class 4. Rot until class 1 is acceptable when no other quality problems are observed.

It should be noted that firmness is linearly related to the water status of the bell peppers. Dehydration of the bell pepper leads to loss in firmness. This is shown in the results, section 'laboratory experiment'. The relation implies that changes in firmness of bell peppers can easily be determined by a simple differential weighing.

The decrease in product quality was assessed by daily determining the quality of the bell peppers, displayed at living room conditions (at RAM Produce: 14-22°C, night/day succession), for maximal 6 days.

Every day the quality class for firmness, shrivelling and rot was determined as an average for the bell peppers per box. In addition, the number of bell peppers not meeting the quality standard (3 for firmness and shrivelling, 1 for rot) was counted per box.

The product quality was determined for bell peppers of 2 shipments, 2 box types/shipment, 2 pallets/box type, 3 rows/pallet, 2 positions/row (inside/outside) and 3 extra storage times/position. This adds up to a total of 144 boxes. However, the third extra storage time of the second shipment was skipped. Thus, the total number of boxes used to determine the product quality was 144 - 24 = 120. The product quality per box was determined 576 times. The quality of individual bell peppers was determined more than 14,000 times.

The remaining 520 boxes (2*320-120) of both shipments were send to the retail outlet. The quality of the bell peppers in these boxes was judged anonymously by customers of the retail. Unsalable product or claims were negative indicators of product quality. No claims were reported.

weight losses

A sample of 25 empty boxes of both types were weighed at the grower to determine the average weight of the bottom and lid. 144 boxes, including the 120 boxes with bell peppers used to determine the product quality at the wholesaler, were filled with product and weighed. Boxes with product were weighed again at the wholesaler to determine the weight losses that occurred during the distribution.

statistical analysis

A statistical personal computer program 'Genstat 5 release 3.2' of the Rothamsted Experimental Station, UK was used for the analysis. The results were tested on a 5% significance level. Differences in weight losses and shelf-life (time until a certain quality level is reached) were analysed by an ANOVA (ANalysis Of Variances).

$$Q(t) = \frac{C}{1 + e^{-A*(t-B)}} \quad (1)$$

$$t = \frac{B - \log(C/c - 1)}{A} \quad (2)$$

The quality aspects firmness, shrivelling and total are discreet variables (fixed values) that needed preprocessing before an ANOVA could be performed. A sigmoidal function (1) was fitted for the time versus average quality class of the bell peppers in a box. This was done for the quality aspects firmness and shrivelling. Rot was hardly found and could not be analysed. Per box two function parameters *A & B* were estimated. *C* was set to 5. The time to reach a certain quality class *c* was calculated (2): the shelf-life value in days.

The quality aspects firmness and shrivelling were also determined for individual bell peppers in a box. The number of bell peppers with quality class >3 were counted as unacceptable. A sigmoidal function (3) was fitted for the time versus the fraction unacceptable bell peppers α in a box (a binomial parameter). Again, this was done for the quality aspects firmness and shrivelling. Per box two function parameters A & B were estimated. The time to reach a certain fraction unacceptable bell peppers per box was calculated (4): the shelf-life value in days.

$$\alpha = \frac{e^{A+B*t}}{1+e^{A+B*t}} \quad (3)$$

$$t = \frac{\log(\frac{\alpha}{1-\alpha}) - A}{B} \quad (4)$$

'laboratory experiment'

In addition to the case study, an experiment at the ATO-DLO was performed. For this experiment, additional boxes with bell peppers from the same harvest were exposed to the conditions expected in the case study. The same methods and similar conditions were used in the laboratory experiment as in the case study. As such, the laboratory experiment is a replicate of the case study, performed at a different location: the laboratory facilities of the ATO-DLO. Of course, slight deviations in conditions were unavoidable as the real life situation is variable and could not be predicted exactly. The small deviations will be described.

The simulated distribution chain used for the laboratory experiment was of the same duration as the case study. The conditions slightly deferred from the case study in temperature and relative humidity. Here, the bell peppers were prechilled by decreasing the temperature from 20° to 10°C in 4 hours. Subsequently, the bell peppers were exposed to a temperature regime of 10 hours at 10°C, 24 hours at 15°C, 8 hours at 23°C, followed by 10°C constant. The relative humidity at all times was 90%.

A comparable pallet stacking pattern was created by using a total of 36 standard and 36 MH boxes. The stacking pattern was efficient: all boxes were used to determine the quality of the bell peppers.

interviews

The new package for bell peppers was introduced to the distribution chain links as a test version that was open for suggestions for further improvements. By interviewing experts, arguments pro- and contra the new design were collected. The interviewed were not solely focussed on bell peppers and the MH box, but generally addressed the subjects quality problems with perishables and packages.

The following persons were interviewed:

1) Anthony Fondacaro; T.H. Weiss, Inc., New York; Air/Sea Customs broker
2) Steve Kernya; Ram Produce, Inc., Detroit; wholesaler
3) Roger Pepperl; Meijer retail, Distribution Centre perishables, Lansing; produce manager
4) Dan Martin; Meijer retail, retail department produce; produce manager

Appendix 2: Case study results of product quality

weights

The weight of empty boxes of the standard box was less than that of the MH box. Especially the lid of the MH box contained more material. Average values, determined for 25 boxes, are shown below. The variation in weight between boxes of a type was very small.

box type	bottom (g)	difference (%)	lid (g)	difference (%)	total	difference (%)
standard	684.4	0	204.2	0	888.6	0
MH	701.6	+2.5	241.9	18.5	943.5	+6.2

The weight of an empty standard and MH box

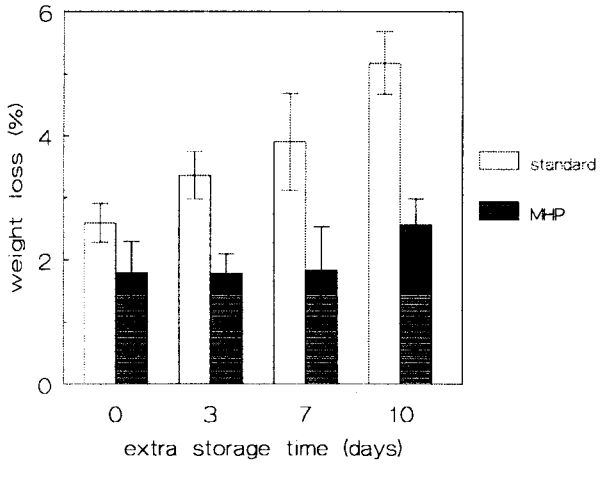


Figure 1 The weight loss of bell peppers.
Lead times are extra storage times plus 4

The bell peppers lost weight due to the evaporation of water during transport. To guarantee a net weight of 5 kg, every box is filled with at least 5.1 kg at the grower. This surplus of product allows a weight loss of about 2 %.

In the case study the bell peppers lost weight, as is shown in the figure 1. For the standard box, this weight loss was just acceptable when the distribution at the wholesaler was not delayed (extra storage time=0). The weight losses were significant higher than 2% for the standard box and extra storage times 3, 7 and 10 days.

In contrast, the weight losses of the bell peppers in the MH box were not different from 2% at all extra storage times. In other words: The norm for the net fill weight of 5 kg was met at all times.

Both box type and extra storage time affected the weight losses significantly. Furthermore, the interaction of box type and extra storage time was significant. The increase in weight loss due to an extra storage time in the distribution was higher for the standard box than for the MH box.

Finally, the position of the box in the pallet had no marked effect on the weight losses of the paprika. Only a slightly higher weight loss of the bell peppers in the top row of the pallet (bottom: 2.6%, middle: 2.7%, top: 2,9%) was observed. This difference was rather small and only significant when the results of both

shipments were combined. A single shipment did not show a significant row effect. Thus, significant row effects were not repeated in this study whereas box type and extra storage time effects were significant and reproducible. The position of the box in the row had no effect on the weight loss. Boxes completely enclosed by other boxes (inside) did not lose more weight than the boxes with one or two sides exposed to the surrounding (outside).

bell pepper quality per box

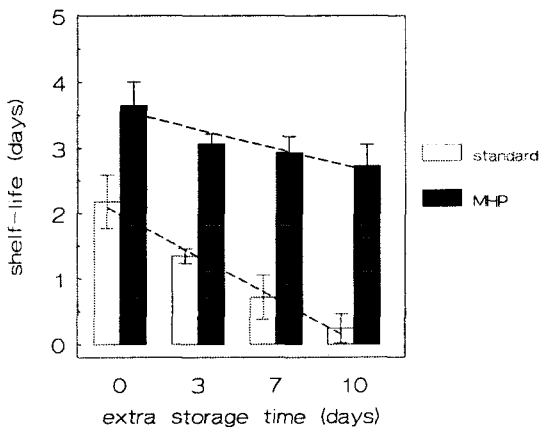


Figure 2 The shelf-life of bell peppers, based on the *average firmness* per box.

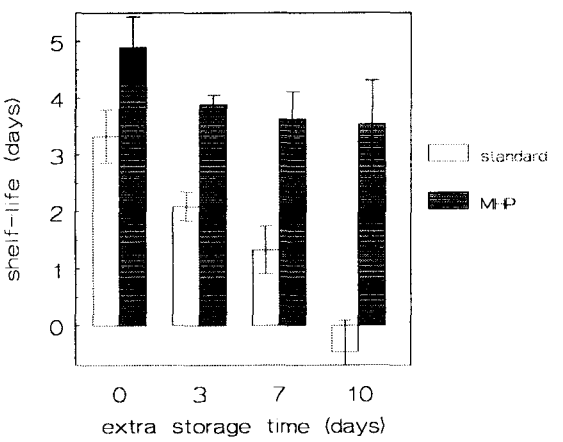


Figure 3 The shelf-life of bell peppers, based on the *average shrivelling* per box.

The time until the average quality of the bell peppers in a box exceeded the value 3 was determined as the shelf-life. The quality level used corresponded with the standard used by traders in the USA. Results for the quality aspects firmness and shrivelling will be shown separately. Rot was also a quality aspect, but the number of bell peppers with rot was too small to allow and justify an analysis. For both box types, less than 5 bell peppers with rot were found.

First, the quality of the bell peppers is judged by the aspect firmness. With this quality aspect, the shelf-life of bell peppers in the standard box was considerably shorter than that of the bell peppers in the MH box (see fig. 2). Effects of an extra storage time in the distribution on the shelf-life are also less for the MH box. As a consequence, the relative extension of the shelf-life by the new box compared to the standard box was 68%, 128%, 309% and 1020% for respectively 0, 3, 7 and 10 days extra storage time in the distribution.

Secondly, the quality of the bell peppers is judged by the aspect shrivelling, see figure 3. As observed above, the bell peppers in the MH box had a longer shelf-life and decrease in shelf-life with time than the bell peppers in the standard box. However, absolute values of the shelf-life based on shrivelling initially exceeds that of the shelf-life based on firmness. This result is consistent with the observation that bell peppers generally show a decrease in firmness before shrivelling starts to show. The higher rate of decrease in shelf-life observed for the standard box is also illustrative. Eventually, the shelf-life became negative which indicates that the bell peppers were already unacceptable at the time of opening the box at the end of the storage time.

quality of individual bell peppers

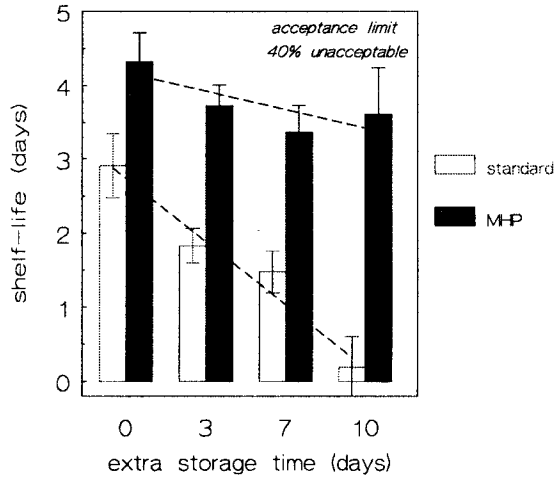


Figure 4 The shelf-life of bell peppers, based on the *total quality per bell pepper*

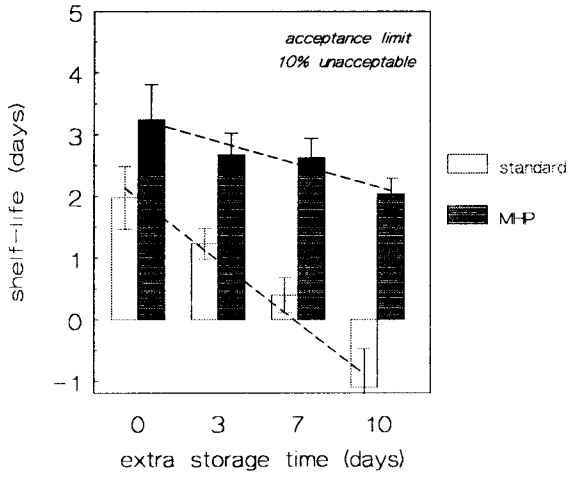


Figure 5 The shelf-life of bell peppers, based on the *total quality per bell pepper*

In addition to the average quality of the bell peppers in a box, the number of bell peppers not meeting an acceptable quality (class > 3) was counted. This again for both quality aspects firmness and shrivelling.
The average quality and the results for individual bell peppers can be slightly biased due to the fact that the first does not account for variation in quality within a box, whereas the latter does.

As a measure for quality, the time until 40% of the bell peppers in a box were unacceptable was chosen. The value of 40% corresponded with the level used by traders in the USA
It corresponded with 10 unacceptable bell peppers out of 25. The fraction chosen determines the absolute value of the shelf-life. E.g. when a fraction of 10% is selected, the shelf-life will be shorter, because a higher quality is demanded.

The influence of the selected quality level is illustrated by comparing the figures 4 and 5. For determining the shelf-life, a fraction of 10% unacceptable bell peppers per box was used in figure 5. Obviously, the higher demand for quality resulted in a decreased shelf-life. However, the differences between the two box types remained similar.

The figure 6 shows the shelf-life for the standard box at different extra storage times. The quality aspects are presented separately: firmness and shrivelling. The contribution of rot is not shown because it was neglectable. The quality of the bell peppers was unacceptable in three cases: firmness > 3, shrivelling > 3 or firmness and shrivelling > 3. For the extra storage times 0, 3 and 7, firmness is the most determining aspect. For extra storage time 10, shrivelling is the most determining aspect.

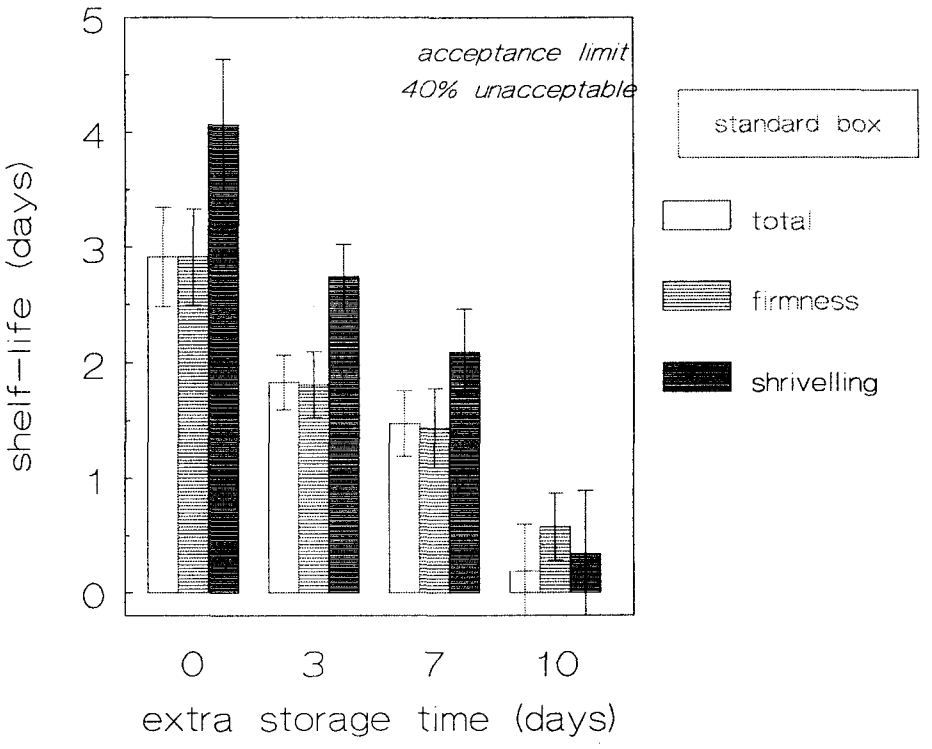


Figure 6 The shelf-life of bell peppers in the standard box. The shelf-life is shown for *total quality, firmness and shrivelling per bell pepper.*

bell pepper quality at the retail outlet

The bell peppers were distributed to the distribution centre of the Meijer retail at Lansing, after several extra storage times at the wholesaler. The maximal lead time of bell peppers in the standard box was 7 days. That for the bell peppers in the MH box 14 days. The difference was caused by the decision of the produce manager at the DC perishables. Bell peppers in the standard box were distributed to the retail outlet much earlier than those in the MH box to avoid an unacceptable quality product. All bell peppers were sold at the retail within 1½ day. Quality problems were not reported, all product was sold and nothing was wasted.

'laboratory experiment'

The tables below summarize the results of the laboratory experiment and the case study. The weight loss and shelf-life for the quality aspects total quality, firmness and shrivelling are shown for bell peppers stored for an extra 0, 3 and 10 days. The quality criterium used is 40% unacceptable bell peppers per box, which agrees with the USA standard for a minimal acceptable quality.

extra storage time (days)	standard box				MH box			
	weight loss (%)	firmness (days)	shrivelling (days)	total (days)	weight loss (%)	firmness (days)	shrivelling (days)	total (days)
0	2.2	2.9	3.8	3.0	1.2	4.2	5.3	4.2
3	3.5	2.8	3.8	2.8	1.8	4.2	5.2	4.2
10	4.7	1.8	2.5	1.8	3.5	3.5	4.2	3.5

A summary of result of the *laboratory experiment*: the quality of bell peppers in a box after a variable storage time.

extra storage time (days)	standard box				MH box			
	weight loss (%)	firmness (days)	shrivelling (days)	total (days)	weight loss (%)	firmness (days)	shrivelling (days)	total (days)
0	2.6	2.9	4.1	2.9	1.8	4.3	5.0	4.3
3	3.3	1.9	2.7	1.8	1.8	3.7	4.3	3.7
7	3.9	1.4	2.1	1.5	1.9	3.4	3.5	3.4
10	5.2	0.6	0.3	0.2	2.6	3.9	1.8	3.6

A summary of result of the *case study*: the quality of bell peppers in a box after a variable storage time.

relation of quality aspects

In addition to the daily assessments of the quality of the bell peppers, the weigths of bell peppers per box were determined. The additional information obtained allows to analyse the relation between loss in weight and the quality of the bell peppers. Two aspects are shown in figure 7: 1) the decrease in the fraction acceptable bell, with a firmness class above 3 and 2) the relation of the weight loss and average firmness, independent of the boxtype.

Obviously, the fraction of unacceptable bell peppers remains 0 until the firmness of individual bell exceeds class 3. From that point on, the fraction unacceptable bell peppers increased. The other aspect is also clear. Bell peppers lose weight and firmness in a linear way. The relation is quite good, 97% of the variation in firmness is explained by the weight loss. As a consequence, changes in firmness can de determined accurately by determining differences in weigths.

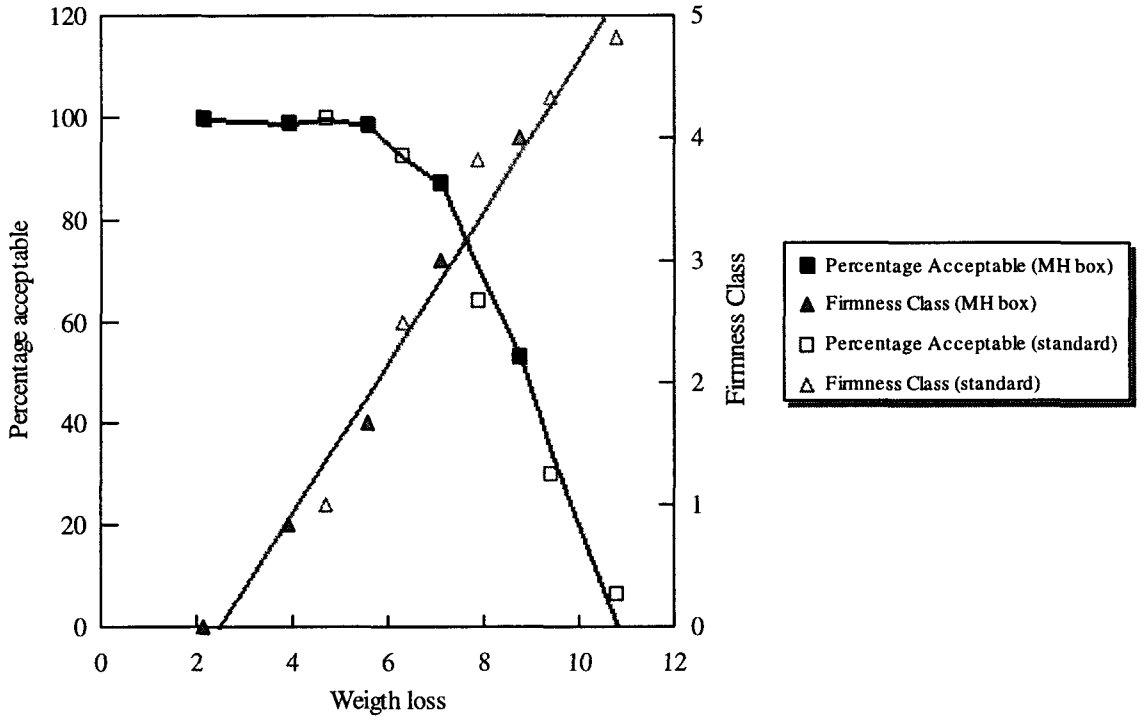


Figure 7 The percentage unacceptable bell peppers per box and the linear relation between firmness and weight loss determined during the display

comparison case study versus laboratory experiment

As found for the case study, the performance of bell peppers in the MH box outranged that of those in the standard box. The small differences in results that evolve in time can be attributed to differences in relative humidity while the bell peppers were displayed. The relatively humid condition of 90% relative humidity of the laboratory experiment was not applied in the case study. Here, the air was more dry and fluctuating between 60% and 85%. Under dry conditions, the quality of the bell peppers decreases faster than under humid conditions. This is quite obvious, water evaporation is the determining process.

Appendix 3: Case study results interviews of distribution chain actors

custom broker

The customs brokerage T.H. Weiss, Inc. At the John F. Kennedy airport in New York was visited by Jan Willem van der Veen and François de Rooij. They interviewed Antony Fondacaro (Tony) on the following topics: 1) the function of the custom broker in the logistic process, 2) the functionality of packages, with emphasis on the incoming 4 pallets of the experiment.

The strict function of a sea/air custom broker is to clear the freights at the customs by forfilling all customs formalities. This task requires filling in documents and arranging the fytosanitairy inspection of the produce: vegetables, fruits and flowers.
Quite a large number of document is involved for the custom clearing of produce. For the bell pepper import approximately 40 documents had to be filled in! Subsequently, the freight has to be inspected by a customs-house officer. Checked are the correctness of the freight. The freight and documents must match. Furthermore, in a fytosanitairy inspection the absence of insects and plagues is visually determined. Maximal 10% of the freight may be inspected.

T.H. Weiss Inc. has a few clients that export large quantities of produce , including Botman International bv, and several clients that export small quantities of produce. The objective of Weiss is to give an optimal service to the clients. This is achieved by reducing the time needed for custom clearing and extending the services offered.

Custom clearing is speeded up from normally 6-9 hours to 3 hours. Less time is needed because the frequency of inspections is lower and inspections are less severe. Several reasons were given. T.H. Weiss is considered to be a reliable custom broker, which helps in reducing the number of freight checks. Furthermore, T.H. Weiss has good relations with the customs-house officers. Finally, the time selected for most custom clearing is at nigh when the customs are (slightly) understaffed.

The service of T.H. Weiss is not limited to customs clearing but also includes optimizing the logistic process, e.g. by exchanging information between distribution chain links, arranging the transport of produce (JIT transport) and taking charge of the freight.

Taking charge of the freight implies that T.H. Weiss is involved in the problems that can occur with product and packages. Mentioned problems with packages were: mechanical damage due to force or humidity. Airplane pallets were unloaded from the airplane by huge lift trucks of ±10 tonne which moved the pallet by either lifting it or forcefully pushing it aside. Considerable damage for packages and products occurs for the latter method, especially for flowers. Another cause of mechanical damage is the tight fastening of the freight by nets. A stronger box will reduce (but not solve) the problem.

While unloading the airplane, the airplane pallets may stand temporary in the rain. This causes problems with the packages: the bottom rows of pallets may collapse and product is damaged. Especially, corrugated board boxes are sensitive. Solid board could be a solution, which is very welcome to T.H. Weiss.

The hight of the lid of a box is important for the customs clearing. The reason for this is that product is taken out of the box for inspection. Lids which are high enough function as a temporary container and after the inspection the product is returned in the box. For lids not high enough, product is spread around on the floor. The product gets filthy or even damaged. Up to 10% of the freight can lose value this way. However, both the standard and the MH box had high enough lids.

In summary, the requirements for packages mentioned by the custom broker were: extended strength, less humidity sensitive, stackability and a good ratio of volume contained by the bottom versus the lid.

wholesaler

The wholesaler Ram Produce Inc. at Detroit was visited by Jan Willem van der Veen, François de Rooij, Henry Boerrigter and Luuk Janssen. The main purpose of the visit was to determine the quality of the bell peppers nearby the end of the distribution chain. Facilities to extend the storage time in the distribution and determine the shelf-life of the product were kindly provided.

Ram Produce Inc. is an intermediate link in the distribution of produce from the airport to the retail. The function of this link is twofold. Firstly, in case that the retail decides not to purchase produce an alternative client can be found. Reasons for canceling a freight by the retail can by quite divers. Obviously, a too low quality product is an important reason. Other reasons can be the availability of low priced local produce. Secondly, Ram Produce Inc. serves as a local buffer where quantities of produce can be cold stored. Delivery from stock allows a faster response to a request for more produce by the retail.

Ram Produce Inc. handles all produce of the Meijer retail chain. The average throughput for Holland produce is ±1500 boxes á 5 kg (11 lbs) a week of bell peppers, and ±2000 boxes á 5 kg a week of tomato on the vine. The quality of the Holland produce is excellent, hardly any problems occur. Problems with local produce are far more frequent.

The extended storage time of the bell peppers achieved by the MH box probably will not be used by Ram Produce Inc. Due to a high throughput, there is no strong need for an extension of the storage time. However, the need can occur when smaller volumes are traded and produce has to be stored for a longer period.

Mentioned requirements for packages were: reduce mechanical problems caused by high humidity and handles for handling the boxes. Remark: the omission of a handle was mentioned because it deviated from the tradition. Further inquiries showed that the omission of a handle is not so important for the handling process.

the Meijer retail chain

history

The Meijer retail chain started in 1934 as a grocery shop called 'Thrift Market' in Grand Rapids, Michigan. A second shop was opened in 1942, a third in 1949. The number of shops has grown steadily., as well as the assortment of each shop. In 1996 the shops the assortment is complete: customers can find all they need. The number of retails is 108, found in the states Michigan, Illinois, Indiana and Ohio. According to Adri Botman, the Dutch produce exporter, the Meijer retail is a good example of the newest developments in the 'high quality' segment of the retails.

	whole Meijer concern ($)		single retail ($)	
	total	perishables	total	perishables
per week	81,000,000	9200,000	750,000	85,000
per year	4200,000,000	475,000,000	39,000,000	4420,000

Value of the throughput of the Meijer retail in 1995 (estimates).

organization

The Meijer retail chain is family owned. Retails and distribution centers are independent 'business units', as well as the departments within the retail. Despite the deregulation of responsibilities, each retail confirms to a mutual concept for the product assortment and presentation.

Perishables and 'bulkfood' are mainly distributed by two DC's, although purchases at local markets is allowed. One DC resides in Lansing, the other in Tipp City. Lansing is ±2 hours driving from Detroit. The objective of the DC perishables is a high throughput and a short lead time. On average, perishables reside 1 to 1½ days in the DC. Retails are delivered on a daily basis. In the morning the fixed volumes of perishables are delivered. In the afternoon additional orders are delivered.

DC retail

The Meijer Distribution Center for perishables at Lansing was visited by Jan Willem van der Veen, François de Rooij, Henry Boerrigter and Luuk Janssen. Roger Pepperl was interviewed on the subjects quality of perishables, with emphasis on Dutch produce, potential new Dutch products and the functionality of packages.

quality and throughput of products

The most important Dutch products, with respect to value and volume, are bell peppers and tomato's on the vine. In general, the quality of Dutch perishables is superior to that of local produce. Normally, 5 to 6% of the perishables is not salable due to a too low quality. In contrast, Dutch perishables are distinguished by a better than average quality and less than 5% is unsalable. As a consequence, the quality requirements for Dutch products are more strict than that for local produce.

Tomato's can be obtained throughout the year. Lands of origin are Holland, Spain and Israel. Domestic produced tomato's derive from Canada and Mexico. These tomato's are of a lower quality and price. Especially the fraction of Mexican tomato's that are not sold can be as high as 10-15%.
The most important quality aspects for tomato's mentioned were firmness and color (red). On both aspects an improvement is required for tomato. A package that can achieve this objective is very welcome.

Tomato on the vine	DC throughput (kg)		whole Meijer concern throughput	
	average	product on sale	average	product on sale
per week	10,000 - 12,500	50,000	20,000 - 25,000	100,000
per year	520,000 - 650,000	1,000,000*	1,040,000 - 1,300,000	2,000,000

* The throughput on a year basis assumes 1 week of promotion activity every month.

Volume of the throughput of the Meijer DC in 1995 for the 'normal' situation and during promotion activity (estimates)

The color is red dominant for bell peppers, followed by orange and yellow. Purple and white bell peppers complete the assortment but the volumes sold are much lower (approximately 30% of volume for red). Dutch bell peppers are purchased in a certain size and quality: diameter 80/100 mm and cat 1^+ ('Super'). The most important quality aspects for bell peppers mentioned were firmness, absence of shriveling and a uniform shape. For all aspects, the Dutch bell peppers are better than the competing bell peppers from Canada and California. Moreover, the domestic produce does not meet the Dutch standard for a 'Super' quality.

Red bell peppers	DC throughput (kg)		whole Meijer concern throughput	
	average	product on sale	average	product on sale
per week	10,000 - 12,500	50,000	20,000 - 25,000	100,000
per year	520,000 - 650,000	1,000,000*	1,040,000 - 1,300,000	2,000,000

* The throughput on a year basis assumes 1 week of promotion activity every month.

Volume of the throughput of the Meijer DC in 1995 for the 'normal' situation and during promotion activity (estimates)

Names of some Dutch products with potential for USA import were asked. Several products were mentioned:
- The first product was 'Belgium Endive'. At this moment, the PGF/CBT of Holland promote this product. Problems with the color of the product still exist: white product exposed to light turns green.
- 'Radicchio Rosso' is interesting, especially for its nice colorful appearance.
- 'Butter Lettuce' is also an excellent quality product. For some unknown reason this Dutch product is not available in the USA, despite the fact that the retail offers a large assortment of lettuce.
- 'Strawberries' are not imported from Holland yet. The supply of strawberry is mainly domestic. The most abundant cultivar is 'Selva'. The fruit of this cultivar are quite firm but the taste by far does nor meet the European standard. Less firm but more tasteful 'hybrids' derive from the coast of California. Here, the temperature can occasionally be high when the morning fog is absent. High temperatures cause deterioration of the fruit quality. Thus, the quality of domestic produced strawberries is not optimal and variable. There is a demand for better tasting and keepable strawberries. Can Holland can supply them in a new box?

requirements for packages
A large variety of mainly corrugated cardboard boxes is used in the DC, but actually throughout the distribution chain. The selection of a certain package for a product is largely traditionally based. This means that the functionality of the packages is not always optimized. Based on experiences with this large variation of packages the following suggestions were given for a new package. Firstly, the dimensions of the packages should be modular to allow an optimal usage of storage facilities. Mixed loads should be interstackable to facilitate the order picking process. Combinations of 60*40 and 40*30 will do. Larger boxes are preferred because they reduce the handling costs. Finally, the product should be protected from mechanical damage. 'Open' trays should have some provision to protect the product. Again, the absence of a handle for the MH box was experienced as an omission.

Retail

characterization
The retail are found in the suburbs of large cities like Detroit. They require a lot of space for the shop and the surrounding parking area, not easily found in the center of cities. The size of the retail, excluding the parking, is ± 25,000 m^2 (±270,000 ft^2). The assortment is approximately 30,000 to 35,000 items.
Customers visit the retail on average 1.7 times a week (modus 1) and stay in the retail for ¾ to 2 hours. 'Prime time' on working days is from 8:30 until 18:30. During the weekend customers mostly shop from 8:30 and 21:30. The retail is open for 24 hours a day and 7 days a week.

produce department
Each retail is divided into several departments. Each of the department is an independent 'business unit' with specific products. One of the departments is for vegetable, fruit and bulk produce. This department is prominent situated, always at one of the entrances of the shop. The average size of this department is ±1860 m^2 (20.000 ft^2). This area contains fixed displays for cold stored produce (±10% of area) and mobile carts to support produce that is not cold stored (±90% area). Cold stored produce are sprayed with water every ±10 minutes. This gives the produce a very 'fresh' appearance. The mobile carts are grouped into so called 'islands' per product group. Tomato's and bell peppers form one group. Apples and pears another. The department has a total of 15 'islands'. A special 'island' displayed consumer packed fruit and vegetables, including prepared food, cooled by melting ice. Produce not cooled during the display is packed in cardboard boxes, with the lids removed. This implies that the number of boxes in the display is large and that the box has an important function in displaying the product.

Not cooled produce is daily supplied during the early morning. From ±5:00 until 8:00 the display is rearranged. The 'islands' are moved to the back room, filled with new produce, and returned to the display area. In the afternoon additional orders are delivered and the displays are rearranged in the display area. The supply of produce is aimed at a remaining volume of 30% at the end of the day. The average lead time in the display of not cooled produce is approximately one day.

product prices
In contrast to the European price market, the USA market for vegetables and fruits is a quality market. For bell peppers, a price ratio of 3 for differences in quality is normal. The California bell peppers of a low quality were sold for ±$1.00/lbs. The higher quality Dutch bell peppers were ±$3.00/lbs. One pound (lbs) is 453.6 gram. One dollar ±fl1.70. This means that the consumers in the USA are willing to pay for a better quality product.

product waists

Vegetables, fruit and bulk produce must meet a minimal quality standard. Selling bad quality produce for a low price is not according the Meijer retail concept and strategy. On average 5 to 6% of the produce is wasted. However, depending on the product strong deviations from this average occur. As mentioned before, a higher fraction of tomato's (10-15%) is wasted. In general, the Dutch products have a quality above average and less than 5 % is wasted.

requirements for packages

The produce which is not cooled is displayed in boxes with the lid removed. This means that the dimensions of the box are a factor in determining the display. Especially the area of visible product is an important marketing tool. Experiences show that the area of displayed product is directly related to the volume of product sold. A high box, like the Dutch box for bell peppers, is not optimal in displaying the product. A lower and larger box is preferred.

Boxes with a larger volume help in reducing the handling costs. The prints on the box are not important to the retail. During the display, most of the printing is not visible to the customers. The printing is more functional during the transport.